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Invention of Low Cost Thermoelectric Generators

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Abstract

The low cost thermoelectric generator (LCTEG) and high performance are investigated. We have investigated a new compound and manufactured locally based area to reduce costs of production. The thermoelectric power generation composed of small n-type (n-$CaMnO_3$) and p-type (p-$Ca_3Co_4O_9$) of 31 couples/ in^2 and the use of thin copper plate and silver paint as electrodes. It was found that the mean voltage is ~121.7 mV, current is ~0.0121mA, power is ~1.47 $^{\mu}$W.

Keywords: low cost thermoelectric generators; n-$CaMnO_3$, p-$Ca_3Co_4O_9$

1. Introduction

Recently, thermoelectric generator (TEG) is a useful device for direct energy conversion [1]. The thermoelectric material is usually evaluated by the dimensionless figure of merit $ZT = S^2\rho T/\kappa$, where S, ρ, T and κ are the Seebeck coefficient, electrical conductivity, absolute temperature and thermal conductivity, respectively. Good thermoelectric materials should simultaneously exhibit lowest κ and highest S and ρ [2]. To obtain high performance thermoelectric generators, bismuth–telluride-based alloys are widely employed [3]. However, they are material as expensive and toxic precursors [4] which its no friendly to environment. For friendly environment, the oxide thermoelectric materials is interested because low or non toxicity and friendly environment [5]. Many oxides have demonstrated good thermoelectric properties such as calcium manganese oxide n-type (n-$CaMnO_3$) [6] and calcium cobalt oxide p-type (p-$Ca_3Co_4O_9$) [7], which we are interesting. Moreover, the $Ca_3Co_4O_9$ can be very easily synthesised from mixing $CaCO_3$ and Co_3O_4 powders and the $CaMnO_3$ can be synthesised from mixing

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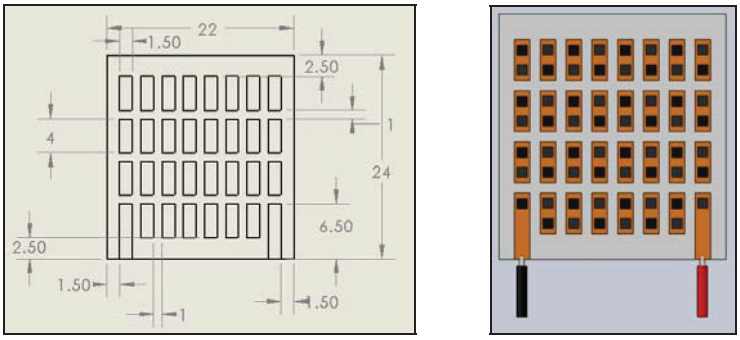
$CaCO_3$ and MnO_2 powders, all call solid state reaction (SSR) method, which the $CaCO_3$ and MnO_2 powders are no expensive. In addition, the $CaCO_3$ is exacted from nature, such as shell and bone etc. So that, the p-$Ca_3Co_4O_9$ and n-$CaMn_2O_3$ compounds are low cost thermoelectric materials for invents TEG.

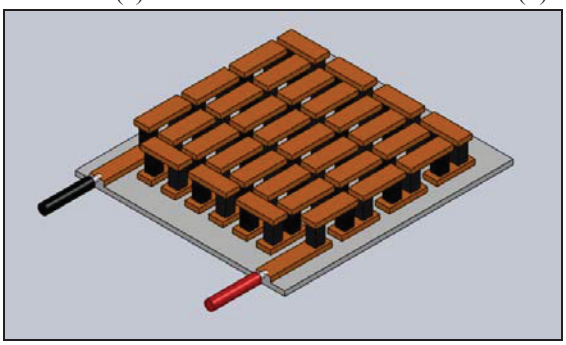
In the present work, we are present the invention of low cost thermoelectric generators. The invented of low cost thermoelectric generators by using p-$Ca_3Co_4O_9$ and n-$CaMn_2O_3$ compounds which synthesized with myself by SSR method. The very easily synthesis TE materials and invention TEG is defined of this low cost thermoelectric generators.

2. Material and methods

The low cost invention of the thermoelectric generator composed of the designed circuit in solid work programs shown below in Fig. 1, prepares p-$Ca_3Co_4O_9$ and n-$CaMn_2O_3$ thermoelectric materials of 31 couples/ in^2 and fabricated, as shown in Fig. 2. The TEG could changed west heat due to electrical at differential temperature. We designed and fabricated thermoelectric generator using thermo segments size of 1 × 1 × 2.5 mm^3 to thermoelectric cell and array by electrode of thin copper plate size of 1.5 × 4 × 0.5 mm^3 and silver paint. The electrical voltage, electrical current and electrical power were measured at the differential temperature range of <200 K and set load for measurement electrical current at 10 kΩ.



(a) (b)



(b)

Fig. 1. The solid work programs design (a) circuit board, (b) schematic of input thermoelectric materials and (c) schematic of thermoelectric generator in three dimension

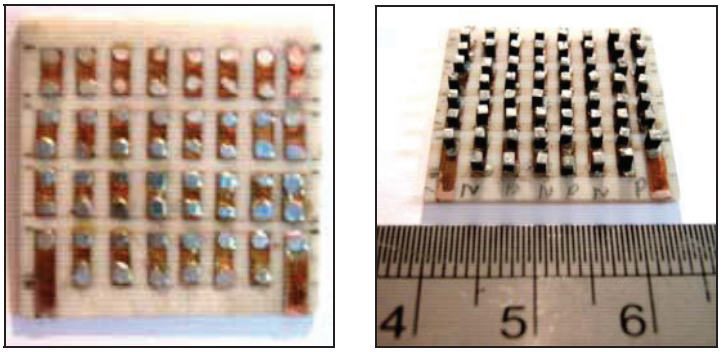


Fig. 2. The fabricated low cost thermoelectric generator (a) the copper electrodes and (b) TE material electrodes with silver paint, respectively

3. Results and Discussion

The differential temperature dependence of electric voltage and electric current for TEG is showed in Fig. 3. The electric voltage and electric current are increased with the increasing differential temperature. The relationship of electric voltage and electric current is following of Ohm law, because set load for electrical current measurements at 10 kΩ. The electric voltage and electric current values are used for plot I-V curve and calculation electrical power. The relationship of I-V curve and electrical power are showed in Fig. 4.

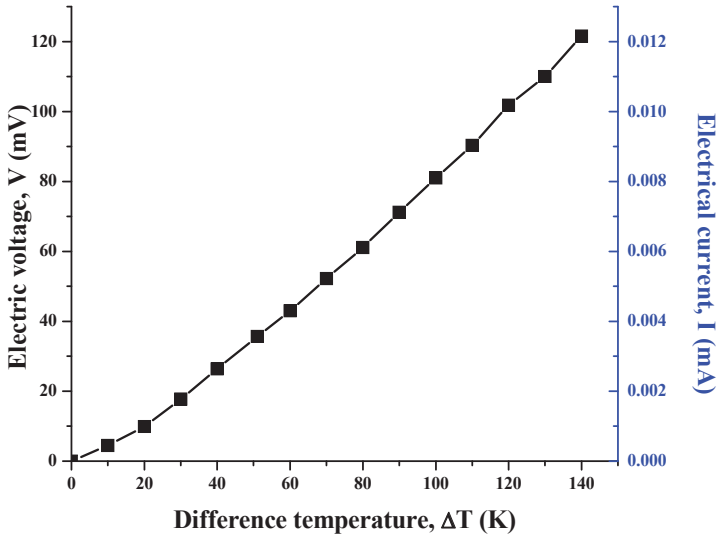


Fig. 3. The difference temperature dependence of electric voltage of TEG in at the differential temperature range 0-200 K

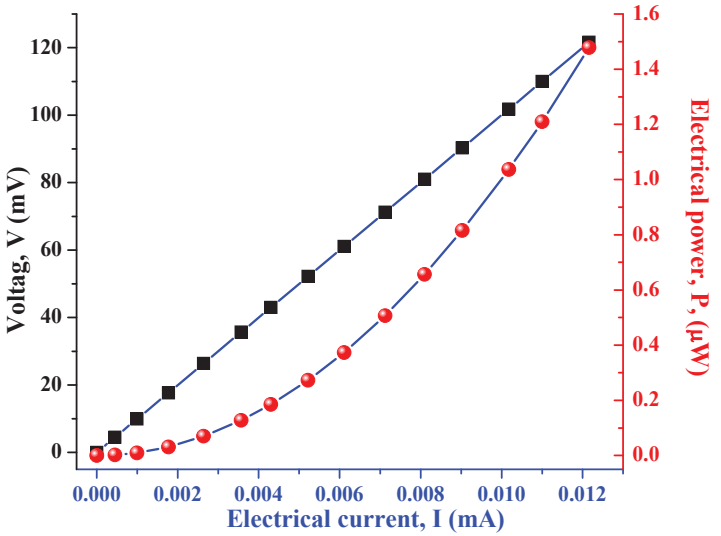


Fig. 4. The relationship of I-V curve and electrical power of TEG in at the differential temperature range 0-200 K

4. Conclusion

The low cost thermoelectric generator fabricated with small n-type (n-$CaMnO_3$) and p-type (p-$Ca_3Co_4O_9$) of 31 couples/ in^2 with the use of thin copper plate and silver paint as electrodes. The maximum electrical values V, I, P of thermoelectric generator are ~121.7 mV, ~0.0121mA, and ~1.47 μW.

Acknowledgements

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